

## STRUCTURE OF MATTER

As a result of working with different materials and learning theories about the structure of matter:

**Students understand the basic structure of atoms and the properties of elements.**

- ***Describe the basic structure of atoms (including protons, neutrons and electrons) and how the atoms of one element are alike and different from other elements. (PIA1)***

The chemical properties of an element are determined by its

- a. atomic mass.
- b. proton number.
- c. electron arrangement.
- d. atomic size.

The atomic number of iron is 26, and the atomic mass is 55.847. What do these numbers mean in regard to protons, electrons and neutrons?

- a. There are 26 each of protons and neutrons, and the rest of the mass is the result of electrons.
- b. There are 26 protons and 26 electrons. Some atoms of iron have 29 neutrons; the .847 shows that there is more than one isotope of iron.
- c. There are 26 protons and 29 neutrons. Each particle has an atomic mass of 1.
- d. There are 26 protons and 26 neutrons. Since neutrons have slightly more mass than protons, the mass is greater than 52.

Study the table below. Which atom has a net positive charge?

Atom	Number of Protons	Number of Neutrons	Number of Electrons
W	3	4	3
X	53	57	53
Y	55	60	54
Z	1	0	1

- a. Atom W
- b. Atom X
- c. Atom Y
- d. Atom Z

- ***Describe the organization of the elements in the periodic table, including the properties and electronic arrangements of elements in the first three periods. (PIA2)***

6 Carbon <b>C</b> 12.011 2,4
14 Silicon <b>Si</b> 28.086 2,8,4
32 Germanium <b>Ge</b> 72.59 2,8,18,4
50 Tin <b>Sn</b> 118.69 2,8,18,18,4
82 Lead <b>Pb</b> 207.19 -18,32,18,4

What do all of the elements listed above have in common?

- They are metals.
- They are in the same period.
- They have the same number of electrons.
- They have four electrons in their outer shells.

Refer to this portion of the periodic table to answer the question that follows.

3 Lithium <b>Li</b> 6.939 2,1	4 Beryllium <b>Be</b> 9.01218 2,2	5 Boron <b>B</b> 10.81 2,3	6 Carbon <b>C</b> 12.011 2,4	7 Nitrogen <b>N</b> 14.0067 2,6	8 Oxygen <b>O</b> 15.9994 2,6	9 Fluorine <b>F</b> 18.9984 2,7	10 Neon <b>Ne</b> 20.183 2,8
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Which element in this group would be the **least likely** to react with other elements?

- Boron
- Carbon
- Neon
- Oxygen

Which of the following is the **most** important factor in determining an element's place in the periodic table?

- number of protons
- number of neutrons
- atomic charge
- atomic density

The pictures below show the position of different elements on the periodic table. Which picture has an X in the locations of the three elements that would be most similar in the way they react?

A.

X		
X		
X		

B.

X	X	X

C.

X		
	X	
		X

D.

		X
	X	
X		

Oxygen has an atomic number of 8. Which of the following elements would you expect to be **most** similar to oxygen in terms of its chemical properties?

- a. Nitrogen (N)
- b. Fluorine (F)
- c. Sulfur (S)
- d. Chlorine (Cl)

**Students understand the use of physical and chemical properties to classify and describe matter.**

- ***Describe the different physical properties that are used to classify matter, including density, melting point and boiling point. (PIB1)***

Archimedes, a Greek mathematician and physicist who lived more than 2200 years ago, is given credit for first discovering that:

**An object immersed in a fluid will be pushed up by a buoyant force equal to the weight of the fluid displaced by the object.**

The following are several ideas that relate to the statement above.

#### **Floating Objects**

- An object placed in a fluid will sink into the fluid until it has displaced a volume of fluid whose weight is equal to the weight of the object.
- An object will float in a fluid when the object has a density less than the density of the fluid.

#### **Sinking Objects**

- When an object sinks in a fluid, it displaces exactly its own volume of the fluid.
- An object will sink in a fluid when the object has a density greater than the density of the fluid.

#### **Density**

- The density of a substance is its mass divided by its volume.
- The density of water is one gram per cubic centimeter (1 g/cm<sup>3</sup>)

Use the above information to help you answer the following questions.

A wooden ball with a density of 0.8 grams per cubic centimeter ( $\text{g/cm}^3$ ) and an aluminum ball with a density of  $2.7 \text{ g/cm}^3$  are exactly the same size. Both are put in a glass of water. Which of the following statements is true?

- a. Both balls will displace the same volume of water.
- b. The aluminum ball will displace a greater volume of water than the wooden ball.
- c. Both balls will displace the same weight of water.
- d. The wooden ball will displace a greater volume of water than the aluminum ball.

Ice floats in water. From this statement it is reasonable to predict that, when a liter of water freezes to form ice, its \_\_\_\_\_.

- a. density increases
- b. weight increases
- c. density decreases
- d. weight decreases

Ice sinks in methyl alcohol that has a density of .8 grams per cubic centimeter ( $\text{g/cm}^3$ ) but floats in liquid water. Based on this information, which of these conclusions is correct?

- a. Ice is less dense than methyl alcohol.
- b. Frozen water has the same density as liquid water.
- c. The density of ice is between  $0.8 \text{ g/cm}^3$  and  $1 \text{ g/cm}^3$ .
- d. Liquid water will also float on methyl alcohol.

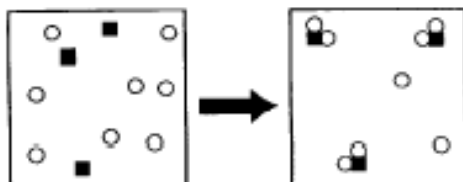
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Some lakes, such as the Great Salt Lake, accumulate soluble minerals, especially salt. In those lakes, people find it much easier to float than when they are in fresh water. Why is this?

- a. The salt water has a greater density than fresh water.
- b. People displace a smaller volume of fresh water than salt water.
- c. Fresh water is denser causing people to sink.
- d. This effect is only imaginary because floating depends on the skill of people.

- ***Explain that new substances are formed when atoms combine by transferring or sharing electrons (i.e., ionic and covalent bonding). (PIB2)***

The reaction of element X ( ■ ) with element Y ( ○ ) is represented in the following diagram:



Which equation properly describes the reaction between X and Y?

- $3X + 8Y \rightarrow X_3Y_8$
- $3X + 6Y \rightarrow X_3Y_6$
- $X + 2Y \rightarrow XY_2$
- $3X + 8Y \rightarrow 3XY_2 + 2Y$

- ***Explain the differences among atoms, elements, molecules, compounds and mixtures and give examples of each using common materials. (PIB3)***

**(no examples provided)**

## REACTIONS AND INTERACTIONS

As a result of studying changes in matter and how they occur:

**Students understand the differences between physical and chemical changes in matter.**

- *Describe the physical states of matter (solids, liquids and gases) in terms of the arrangement and motion of particles, and explain how heat is related to changes in the physical state of matter. (PIIA1)*



A child releases a balloon that is partially inflated with helium into the air. What do you think will happen to the size of the balloon as it rises? Explain fully why you think so.

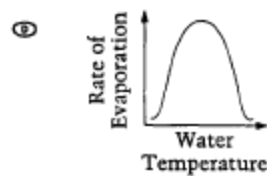
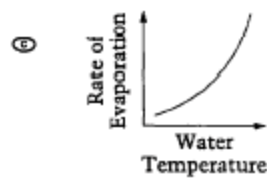
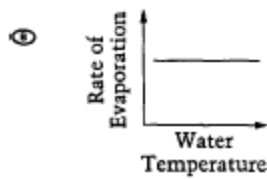
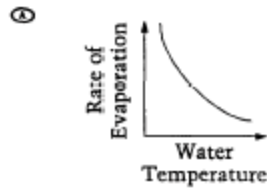
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Which of the following graphs shows how the rate of evaporation changes with changes in water temperature?



During which of the following processes is there a decrease in the heat content of the form of water indicated?

- a. Ice as it forms on a lake
- b. Water droplets as they fall to the ground
- c. Water as it evaporates from a pond
- d. Snow as it melts on a mountainside

As water boils, the arrangement and behavior of the water molecules undergo changes. Describe at least two of these changes.

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When very small particles in a dish of water are examined with a powerful microscope, the particles often appear to move in a rapid, random motion. Explain what causes this movement of the particles.

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- ***Describe the differences between chemical and physical changes in matter and explain how chemical changes involve the rearrangement of molecules, atoms or ions to form new substances. (PIIA2)***

Which method is the **most** effective in removing a salt from a solution of water?

- A. Pour the water from the solution.
- B. Use a magnet to attract the salt.
- C. Allow the water to evaporate.
- D. Pour the solution through a filter paper.

In a beaker, sugar is dissolved in water, and then the water is heated and evaporates. The sugar is recovered, and heat is again applied. Vapor is released, and the material in the beaker changes from white to black. What must you know to determine if a chemical change occurred?

- a. the boiling point of water
- b. the boiling point of sugar
- c. the temperature at which sugar evaporates
- d. whether or not the black substance is sugar

**Students understand that materials interact with each other in various forms.**

- ***Explain that the total matter and energy are conserved in synthesis and decomposition reactions. (PIIB1)***

In an experiment, 12.0 grams of solid carbon reacted with oxygen gas to form 44.0 grams of carbon dioxide gas. How many grams of oxygen reacted with the carbon?

- a. 12.0 grams
- b. 32.0 grams
- c. 44.0 grams
- d. 56.0 grams

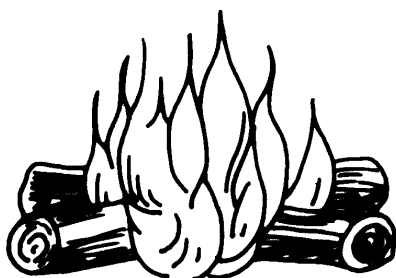
A balanced chemical equation reflects the idea that the mass of the products

- a. is greater than the mass of the reactants.
- b. is less than the mass of the reactants.
- c. equals the mass of the reactants.
- d. is not related to the mass of the reactants.

- ***Describe combustion and corrosion reactions of materials with oxygen (i.e., burning, respiration and rusting). (PIIB2)***

When steel wool rusts, the iron in the steel wool combines with

- a. nitrogen
- b. carbon dioxide
- c. oxygen
- d. hydrogen



Which of the following statements best describes the energy transformation that occurs when a log burns?

- a. Mechanical energy changes to chemical energy.
- b. Chemical energy changes to heat and light energy.
- c. Heat and light energy changes to chemical energy.
- d. Mechanical energy changes to heat and light energy.

A log was burned in a fireplace. Which statement is true about the leftover ashes when they are compared to the original unburned log?

- a. The ashes have more mechanical energy than the unburned log.
- b. The ashes occupy the same amount of space as the unburned log.
- c. The ashes have less chemical energy than the unburned log.
- d. The ashes have the same molecular structure as the unburned log.

Which of the following equations best represents the burning of a log?

- a.  $\text{Wood} + \text{CO}_2 \rightarrow \text{O}_2 + \text{H}_2\text{O} + \text{energy}$
- b.  $\text{Wood} + \text{O}_2 \rightarrow \text{CO}_2 + \text{H}_2\text{O} + \text{energy}$
- c.  $\text{Wood} + \text{H}_2\text{O} \rightarrow \text{O}_2 + \text{CO}_2 + \text{energy}$
- d.  $\text{Wood} \rightarrow \text{CO}_2 + \text{O}_2 + \text{H}_2\text{O} + \text{energy}$

- ***Describe the chemical structures and properties of acids and bases and relate them to the properties of common household products. (PIIB3)***

Natasha is concerned about acid rain. A snow sample has a pH of 6.5. Natasha proposes explanations for the observed pH. Which explanation is **most** reasonable?

- a. The slightly basic pH represents clean air.
- b. The slightly acidic pH represents clean air.
- c. The acidic pH indicates that a pollution source must be upwind.
- d. The basic pH indicates that a pollution source must be upwind.